We claim:

1. A doped semiconductor nanocrystal layer comprising (a) a group IV oxide layer which is free of ion implantation damage, (b) from 30 to 50 atomic percent of a semiconductor nanocrystal distributed in the group IV oxide layer, and (c) from 0.5 to 15 atomic percent of one or more rare earth element, the one or more rare earth element being (i) dispersed on the surface of the semiconductor nanocrystal and (ii) distributed substantially equally through the thickness of the group IV oxide layer.

2. A doped semiconductor nanocrystal layer according to claim 1, wherein the group IV oxide layer comprises silicon dioxide or germanium dioxide.

3. A doped semiconductor nanocrystal layer according to claim 1, wherein the group IV oxide layer has a thickness of from 1 to 2000 nm.

4. A doped semiconductor nanocrystal layer according to claim 1, wherein the group IV oxide layer has a thickness of from 80 to 2000 nm.

5. A doped semiconductor nanocrystal layer according to claim 1, wherein the group IV oxide layer has a thickness of from 100 to 250 nm.

6. A doped semiconductor nanocrystal layer according to claim 1, wherein the group IV oxide layer has a thickness of from 1 to 10 nm.

7. A doped semiconductor nanocrystal layer according to claim 1, wherein the semiconductor nanocrystal is a group IV semiconductor, a group II-VI semiconductor or a group III-V semiconductor.

8. A doped semiconductor nanocrystal layer according to claim 7, wherein the group IV semiconductor is selected from Si, Ge, Sn and Pb.

9. A doped semiconductor nanocrystal layer according to claim 7, wherein the group II-VI semiconductor is selected from ZnO, ZnS, ZnSe, CaS, CaTe and CaSe.

10. A doped semiconductor nanocrystal layer according to claim 7, wherein the group III-I semiconductor is selected from GaN, GaP and GaAs.

11. A doped semiconductor nanocrystal layer according to claim 1, wherein the concentration of semiconductor nanocrystals in the group IV oxide layer is from 37 to 47 atomic percent.

12. A doped semiconductor nanocrystal layer according to claim 1, wherein the concentration of semiconductor nanocrystals in the group IV oxide layer is from 40 to 45 atomic percent.

13. A doped semiconductor nanocrystal layer according to claim 1, wherein the semiconductor nanocrystals are from 1 to 10 nm in size.

14. A doped semiconductor nanocrystal layer according to claim 1, wherein the semiconductor nanocrystals are from 1 to 3 nm in size.

15. A doped semiconductor nanocrystal layer according to claim 1, wherein the semiconductor nanocrystals are from 1 to 2 nm in size.

16. A doped semiconductor nanocrystal layer according to claim 1, wherein the rare earth element is selected from cerium, praseodymium, neodymium, promethium, gadolinium,

erbium, thulium, ytterbium, samarium, dysprosium, terbium, europium, holmium, lutetium, and thorium.

17. A doped semiconductor nanocrystal layer according to claim 16, wherein the rare earth element is selected from erbium, thulium and europium.

18. A doped semiconductor nanocrystal layer according to claim 1, wherein the rare earth element is in the form of an oxide or a halogenide.

19. A doped semiconductor nanocrystal layer according to claim 18, wherein the halogenide is a fluoride.

20. A doped semiconductor nanocrystal layer according to claim 1, wherein the rare earth concentration is from 5 to 15 atomic percent.

21. A doped semiconductor nanocrystal layer according to claim 1, wherein the rare earth concentration is from 10 to 15 atomic percent.

22. A semiconductor structure comprising a substrate, on which substrate is deposited one or more doped semiconductor nanocrystal layers according to claim 1.

23. A semiconductor structure according to claim 22, wherein the substrate is selected from a silicon wafers or a poly silicon layer, either of which can be optionally n-doped or p-doped, and a layer of fused silica, zinc oxide, quartz or sapphire.

24. A semiconductor structure according to claim 22, wherein the semiconductor structure comprises one or more dielectric layer.

25. A semiconductor structure according to claim 24, wherein the dielectric layer comprise silicon oxide, silicon nitrite or silicon oxy nitrite.

26. A semiconductor structure according to claim 24, wherein the dielectric layer has a thickness of 1 to 10 nm.

27. A semiconductor structure according to claim 24, wherein the dielectric layer has a thickness of 1 to 3 nm.

28. A semiconductor structure according to claim 24, wherein the dielectric layer has a thickness of about 1.5 nm.

29. A semiconductor structure according to claim 22, wherein the semiconductor structure comprises a current injection layer.

30. A semiconductor structure according to claim 29, wherein the current injection layer is an indium tin oxide layer.

31. A semiconductor structure according to claim 22, wherein the semiconductor structure has a thickness of 2000 nm or less.

32. A process for preparing a doped semiconductor nanocrystal layer, the process comprising:

(a) subjecting a target comprising a mixture of (i) a powdered group IV binding agent, (ii) a powdered semiconductor selected from a group IV semiconductor, a group II-VI semiconductor and a group III-V semiconductor, and (iii) a powdered rare earth element, the rare earth element being present in concentration of 0.5 to 15 atomic percent, to a pulse laser deposition procedure to deposit a semiconductor rich group IV oxide layer doped with a rare earth element, and

(b) annealing the semiconductor rich group IV oxide layer doped with a rare earth element at a temperature of from 600°C to 1000°C.

33. A process according to claim 32, wherein the powdered group IV binding agent is selected from silicon oxide, germanium oxide, lead oxide and tin oxide.

34. A process according to claim 32, wherein the powdered group IV binding agent is selected from silicon, germanium, lead and tin, and wherein the pulse laser deposition procedure is carried out under an oxygen atmosphere.

35. A process according to claim 34, wherein the oxygen atmosphere has a pressure suitable to obtain the semiconductor rich group IV oxide layer with 30 to 50 atomic percent of excess semiconductor.

36. A process according to claim 32, wherein the group IV semiconductor is selected from Si, Ge, Sn and Pb.

37. A process according to claim 32, wherein the group II-VI semiconductor is selected from ZnO, ZnS, ZnSe, CaS, CaTe and CaSe.

38. A process according to claim 32, wherein the group III-I semiconductor is selected from GaN, GaP and GaAs.

39. A process according to claim 32, wherein the powdered rare earth element is selected from cerium, praseodymium, neodymium, promethium, gadolinium, erbium, thulium, ytterbium, samarium, dysprosium, terbium, europium, holmium, lutetium, and thorium.

40. A process according to claim 32, wherein the powdered rare earth element is selected from erbium, thulium and europium.

41. A process according to claim 32, wherein the powdered rare earth element is in the form of an oxide or a halogenide.

42. A process according to claim 40, wherein the halogenide is a fluoride.

43. A process according to claim 32, wherein powdered rare earth element concentration is from 5 to 15 atomic percent.

44. A process according to claim 32, wherein powdered rare earth element concentration is from 10 to 15 atomic percent.

45. A process according to claim 32, wherein the semiconductor rich group IV oxide layer is annealed at a temperature of from 800 to 950°C.

46. A process for preparing a doped semiconductor nanocrystal layer, the process comprising:

(a) introducing (i) a gaseous mixture of a group IV element precursor and molecular oxygen, and (ii) a gaseous rare earth element precursor, in a plasma stream of a Plasma Enhanced chemical Vapor Deposition (PECVD) instrument to form a semiconductor rich group IV oxide layer doped with a rare earth element, and

(b) annealing the semiconductor rich group IV oxide layer doped with a rare earth element at a temperature of from 600°C to 1000°C.

47. A process according to claim 46, wherein the group IV element precursor is a hydride of a group IV element.

48. A process according to claim 46, wherein the group IV element precursor comprises silicon, germanium, tin or lead.

49. A process according to claim 46, wherein the group IV element precursor is silane.

50. A process according to claim 46, wherein the ratio of the group IV element precursor and of the molecular oxygen is selected to obtain the semiconductor rich group IV oxide layer with 30 to 50 atomic percent of excess semiconductor.

51. A process according to claim 46, wherein the rare earth element precursor comprises a rare earth element selected from cerium, praseodymium, neodymium, promethium, gadolinium, erbium, thulium, ytterbium, samarium, dysprosium, terbium, europium, holmium, lutetium, and thorium.

52. A process according to claim 46, wherein the rare earth element precursor comprises erbium, thulium or europium.

53. A process according to claim 46, wherein the rare earth element precursor comprises a ligand selected from 2,2,6,6-tetramethyl-3,5-heptanedione, acetylacetonate, flurolacetonate, 6,6,7,7,8,8,8-heptafluoro-2,2-dimethyl-3,5-octanedione, i-propylcyclopentadienyl, cyclopentadienyl, and n-butylcyclopentadienyl.

54. A process according to claim 46, wherein the rare earth element precursor is selected from tris(2,2,6,6-tetramethyl-3,5-heptanedionato) erbium(III), erbium (III) acetylacetonate hydrate, erbium (III) flurolacetonate, tris(6,6,7,7,8,8,8-heptafluoro-2,2-dimethyl-3,5-octanedionate)erbium (III), tris(i-propylcyclopentadienyl)erbium (III), Tris(cyclopentadienyl)erbium (III), and tris(n-butylcyclopentadienyl)erbium (III).

55. A process according to claim 46, wherein the semiconductor rich group IV oxide layer is annealed at a temperature of from 800 to 950°C.

56. A doped semiconductor nanocrystal layer comprising (a) a group IV oxide layer which is free of ion implantation damage, (b) a semiconductor nanocrystal distributed in the group IV oxide layer, and (c) one or more rare earth element, the one or more rare earth element being dispersed on the surface of the semiconductor nanocrystal.